Comparison of Surface and Satellite Measurements of Cloud Properties in the Arctic

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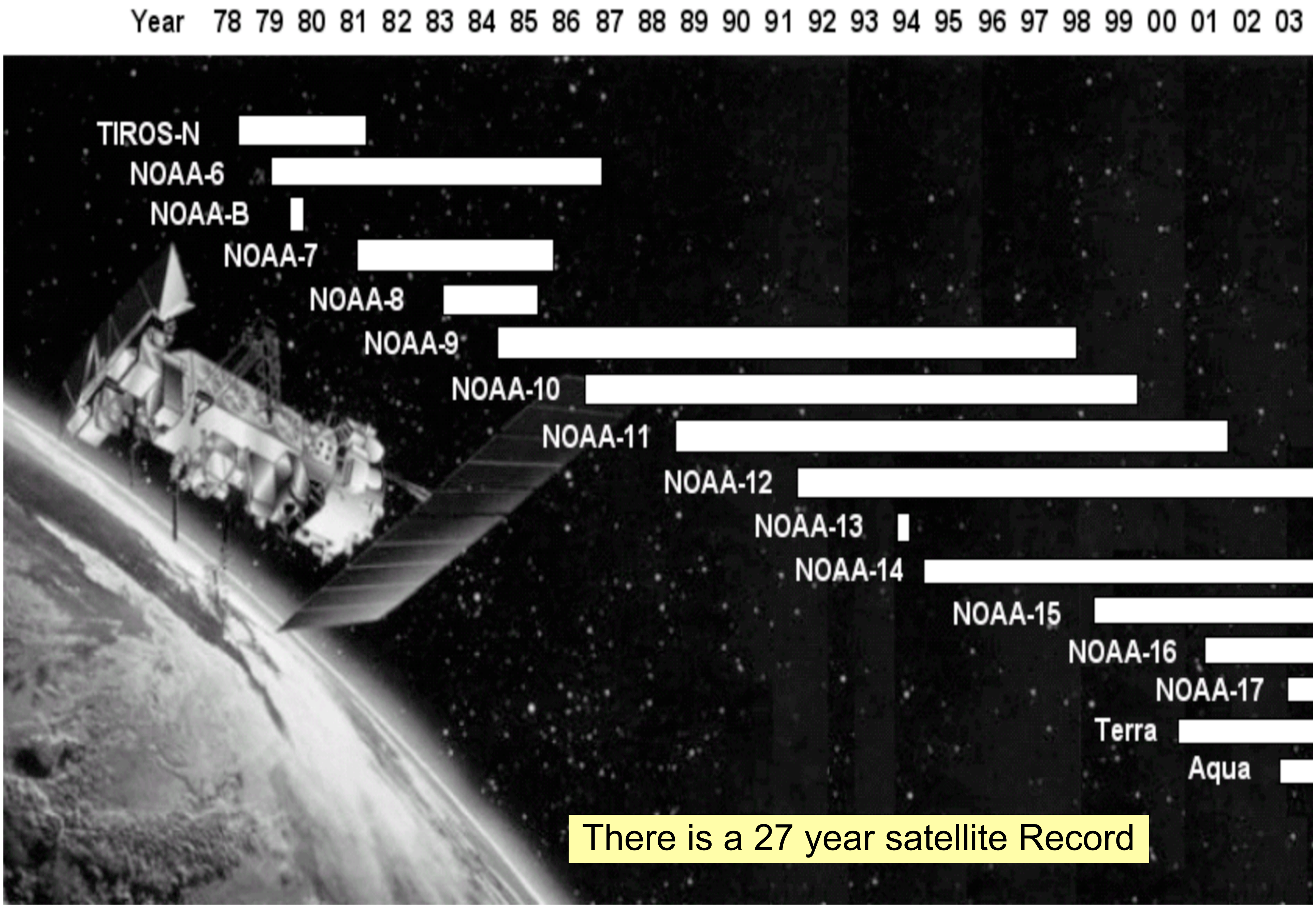
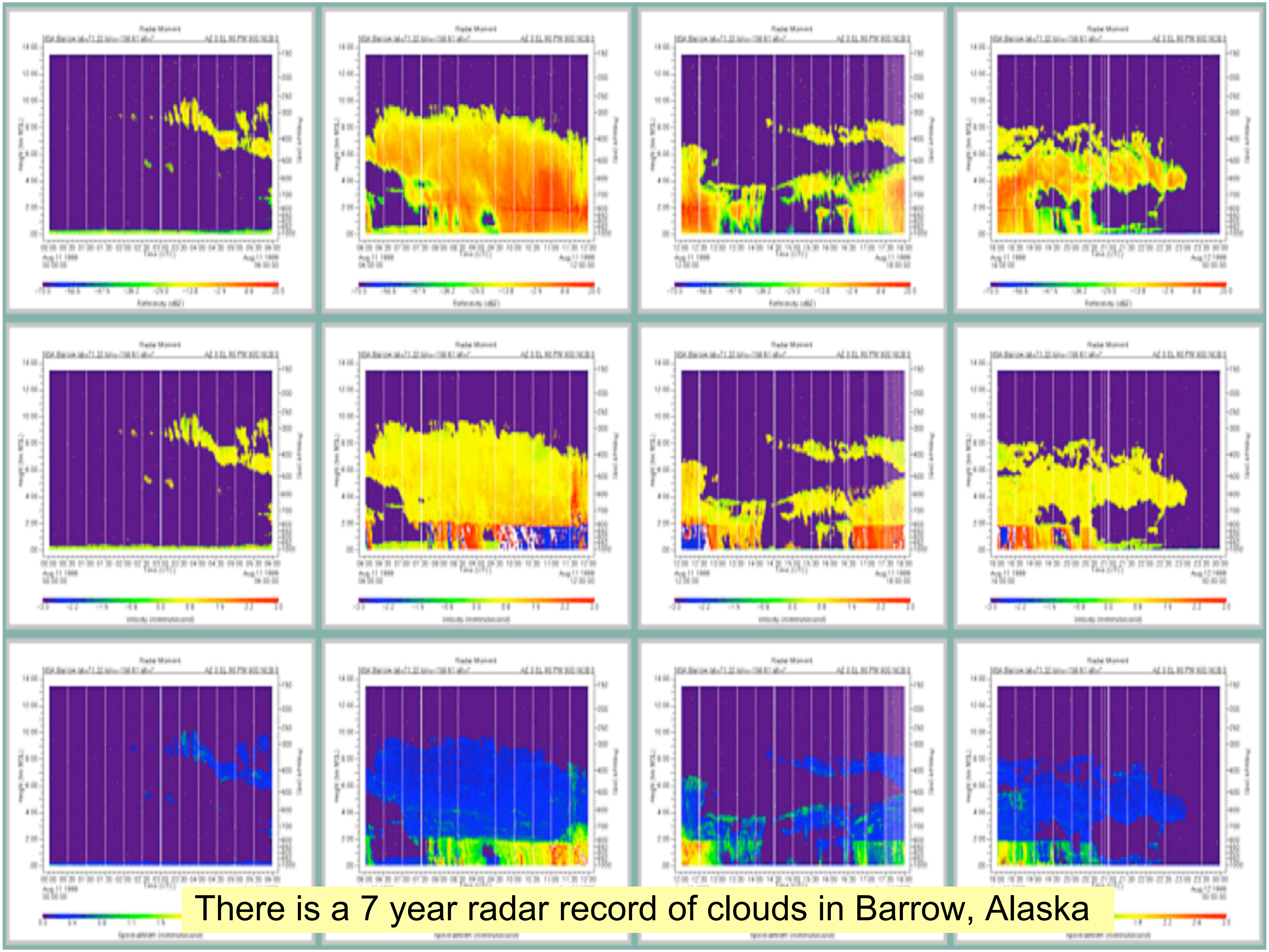
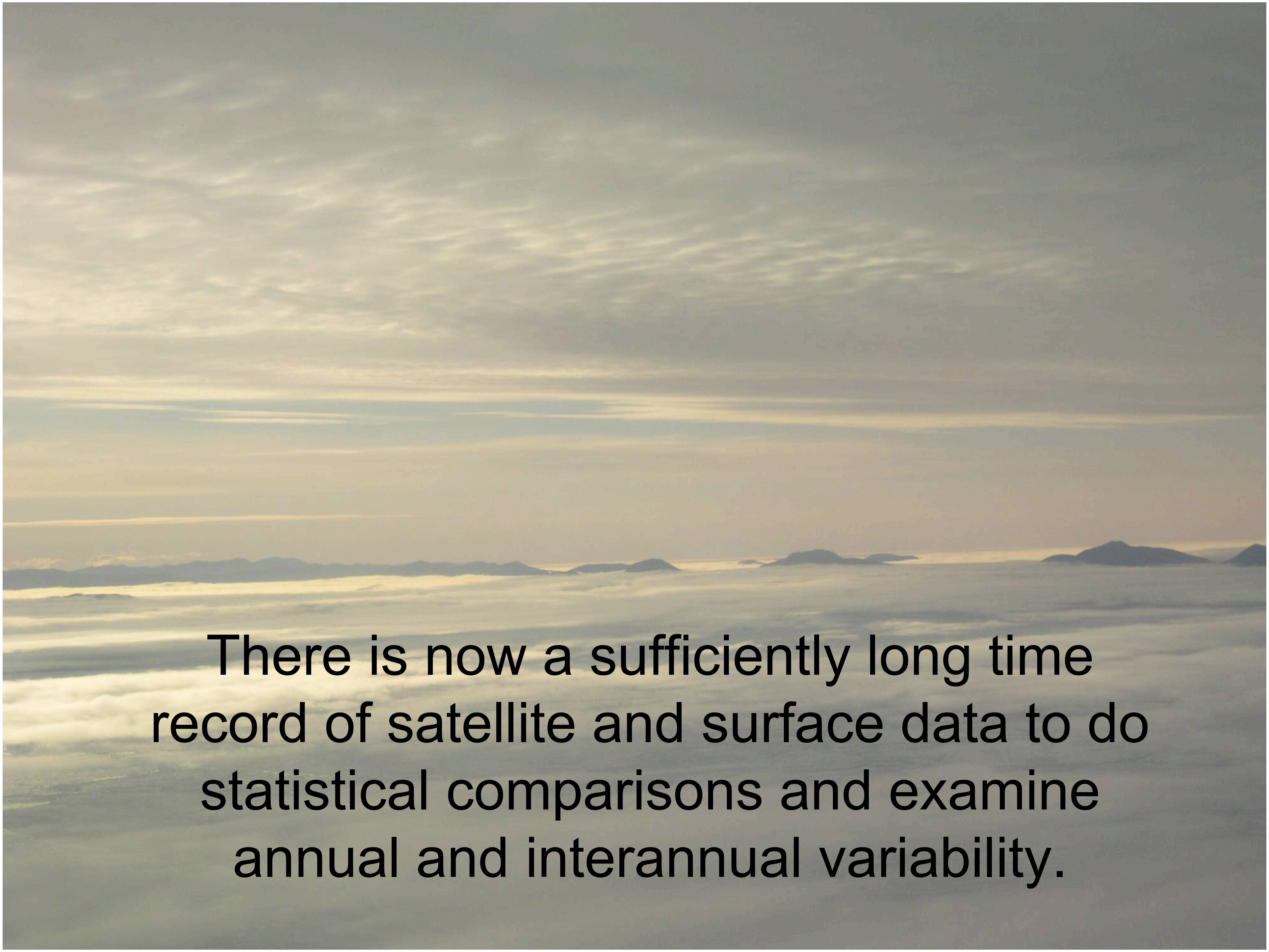
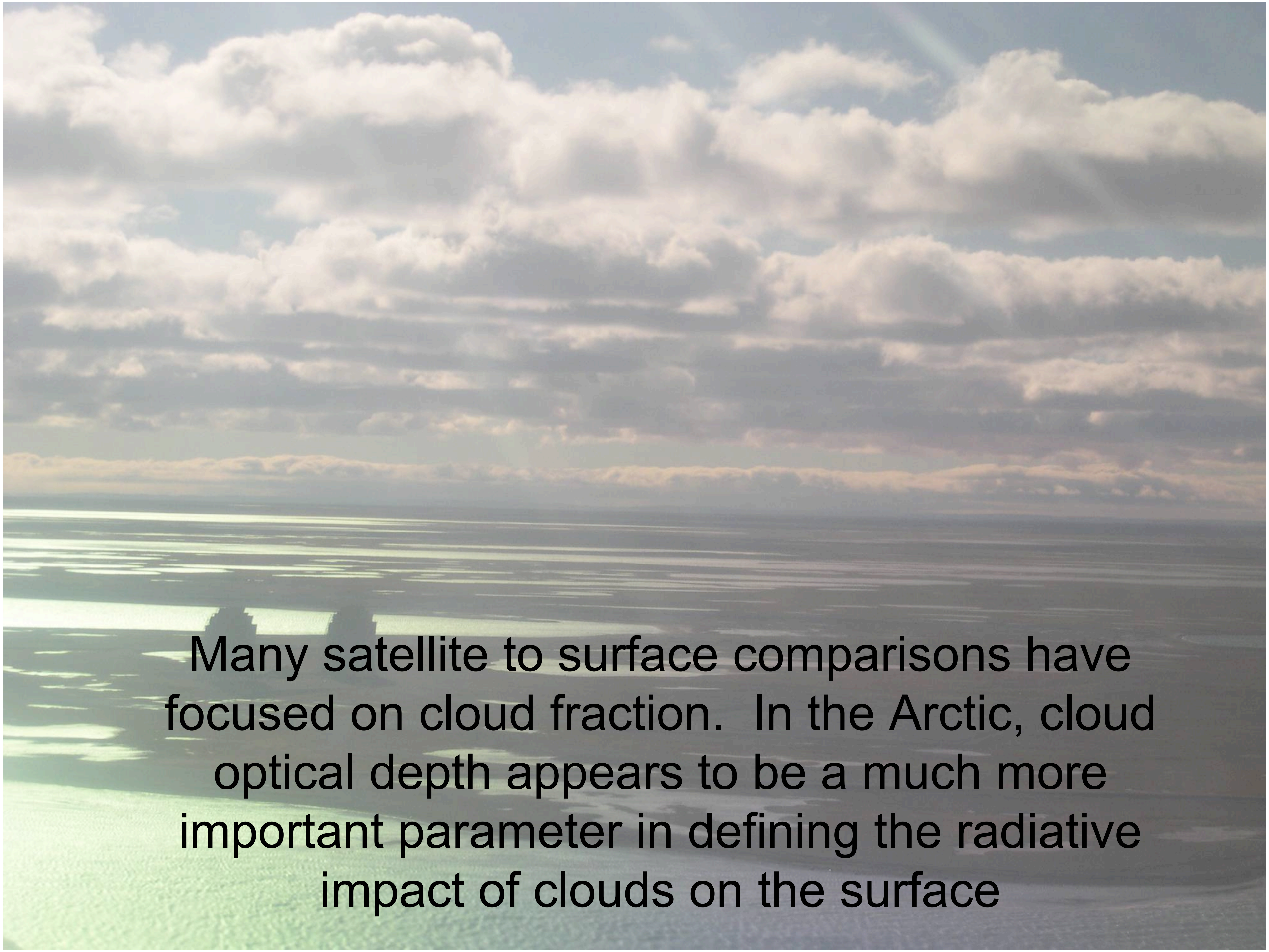
NOAA and NASA Satellite Timeline





There is a 7 year radar record of clouds in Barrow, Alaska


There is now a sufficiently long time record of satellite and surface data to do statistical comparisons and examine annual and interannual variability.


Many satellite to surface comparisons have focused on cloud fraction. In the Arctic, cloud optical depth appears to be a much more important parameter in defining the radiative impact of clouds on the surface

Clouds with liquid (usually supercooled) are the most radiatively significant in the Arctic

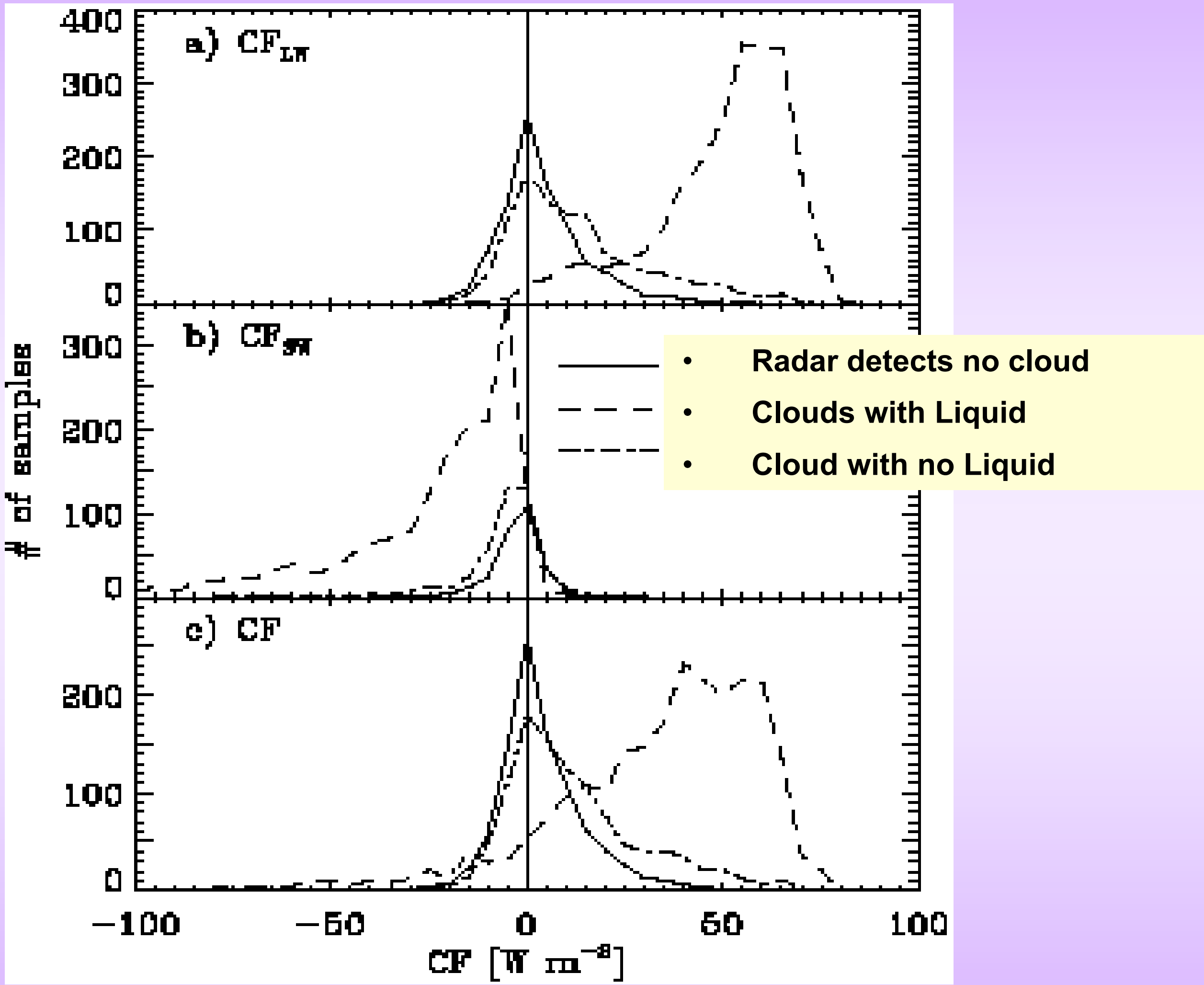


Figure from
Shupe, 2004

The major contribution to optical depth in Arctic clouds is from the liquid layers

Liquid Cloud In the cloud Ice Cloud

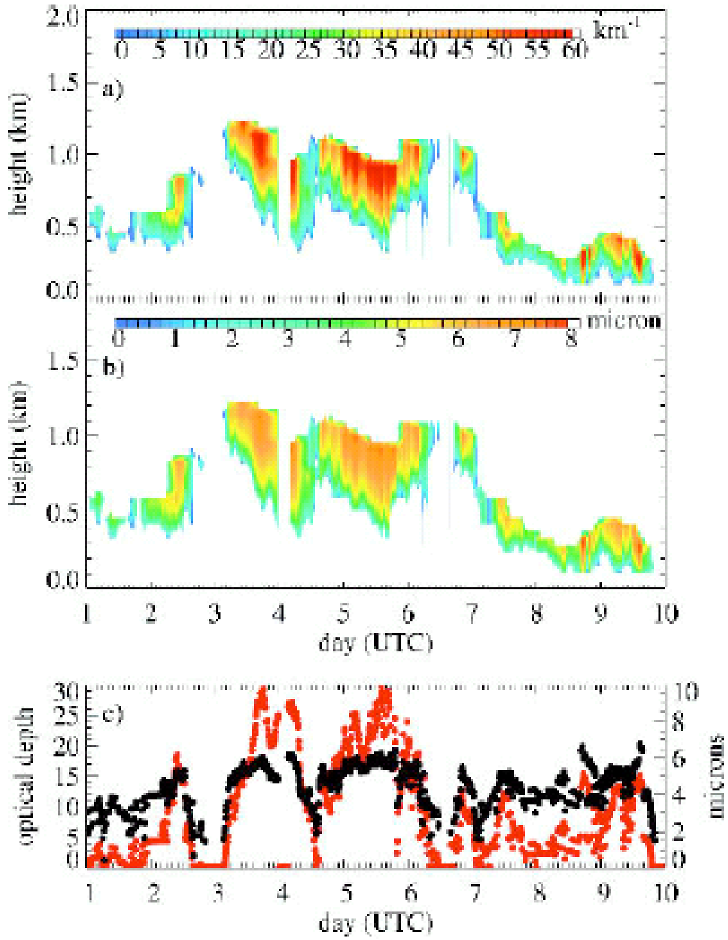


FIG. 8. The liquid (a) volume extinction coefficient, (b) effective radius, and (c) optical depth (red) and layer-mean effective radius (black) calculated from the observed LWC, $\overline{N}$, and $\overline{\sigma_{\log}}$.

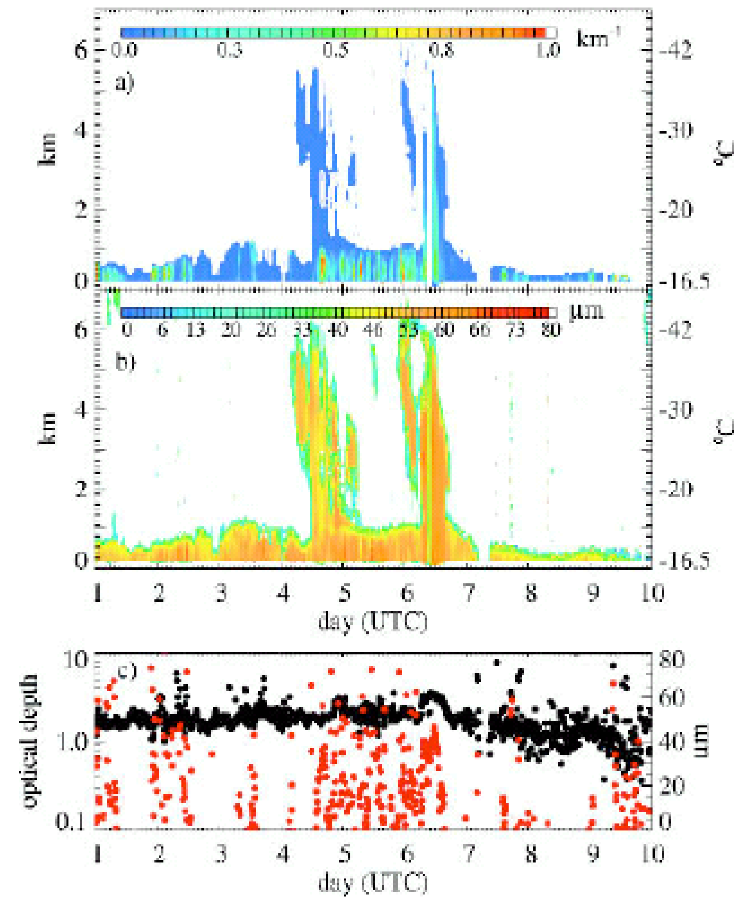
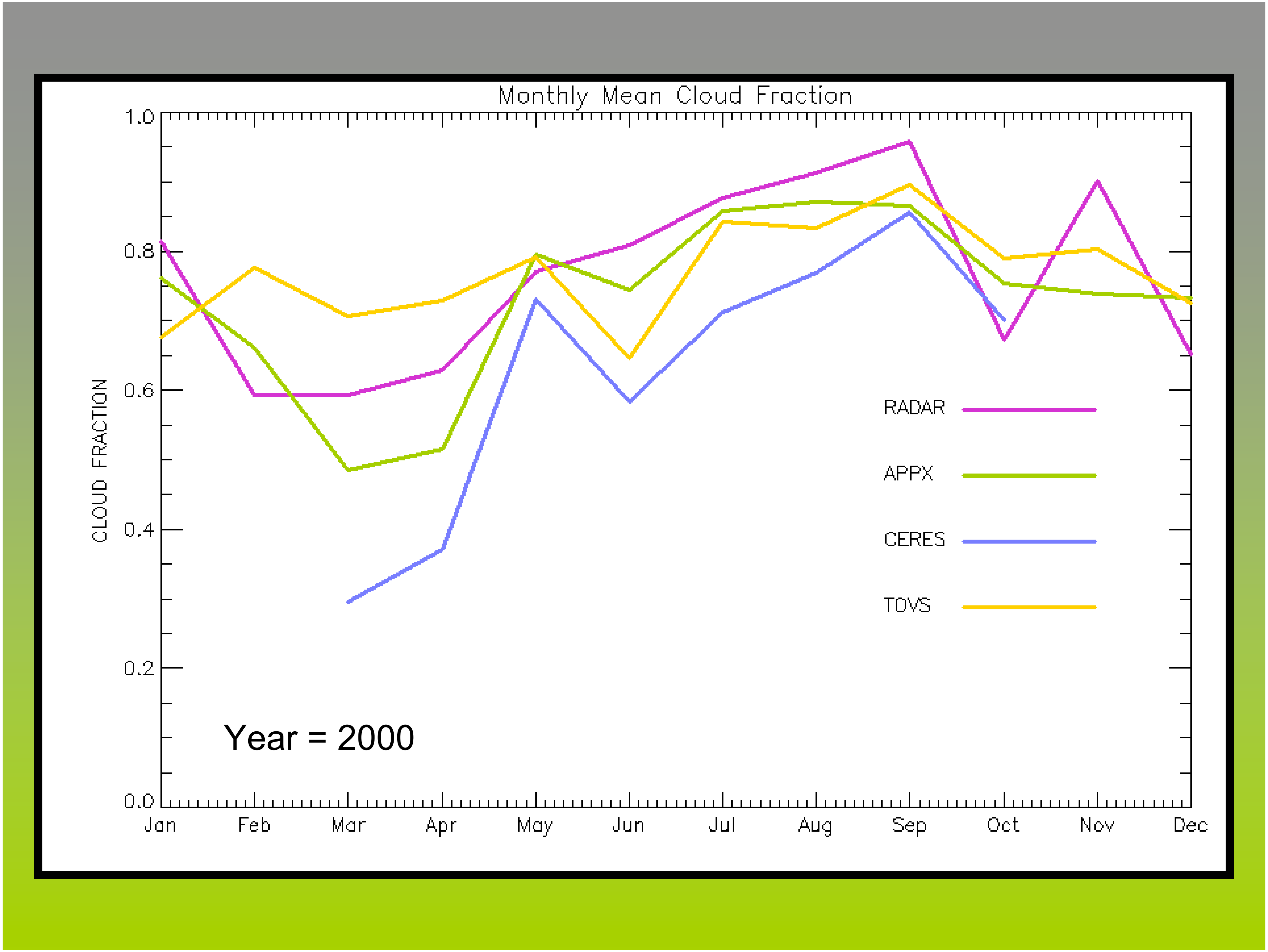
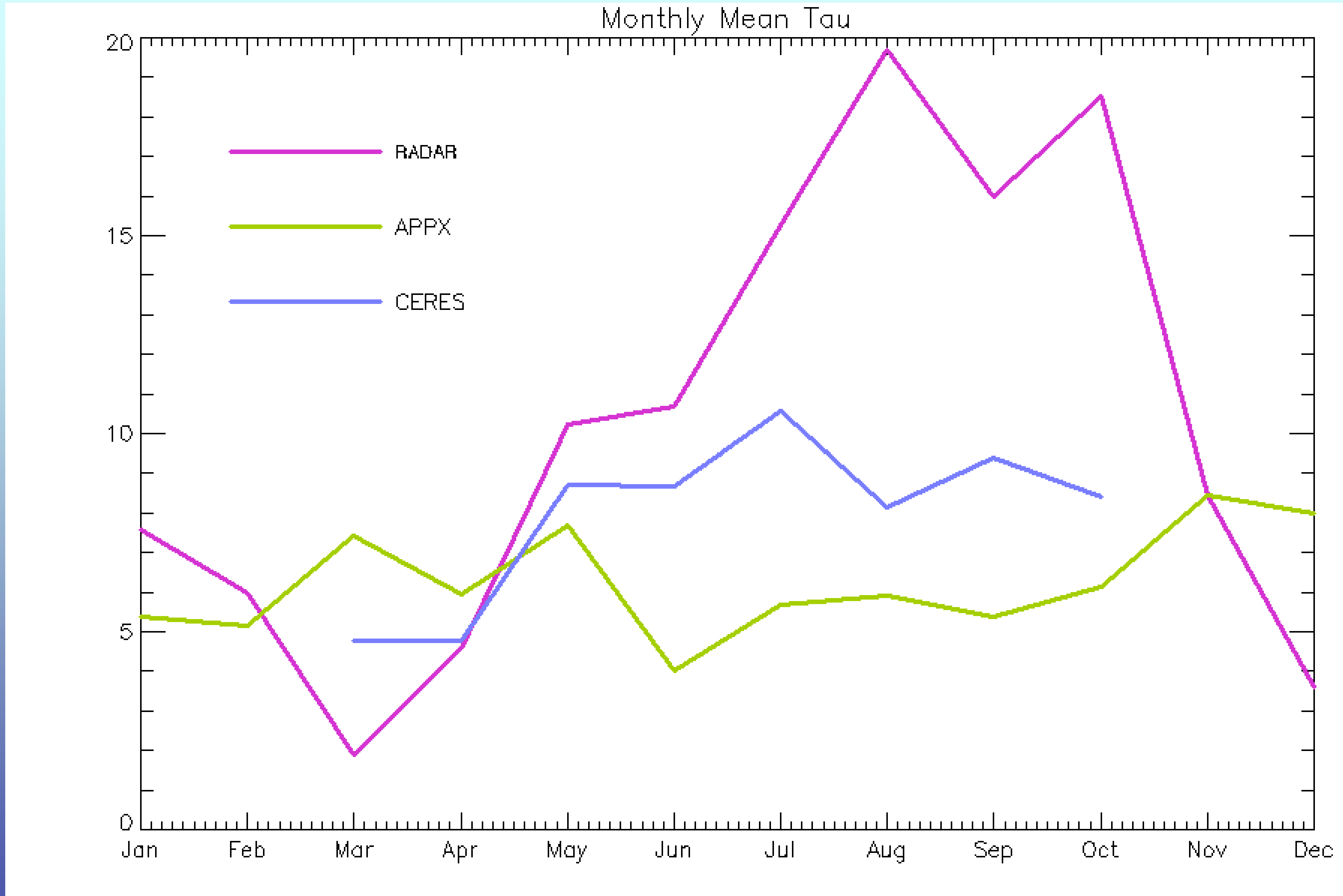


FIG. 10. Radar-retrieved ice (a) volume extinction coefficients, (b) effective ice particle radius, and (c) total ice cloud optical depth (red) and mean effective ice particle radius (black), from 1 to 10 May. Mean temperature sounding values are indicated on the right *y* axis.

The shallow liquid layer contributes 25 times as much to the optical depth as the much thicker ice parts of the cloud.

Zuidema et al.2005

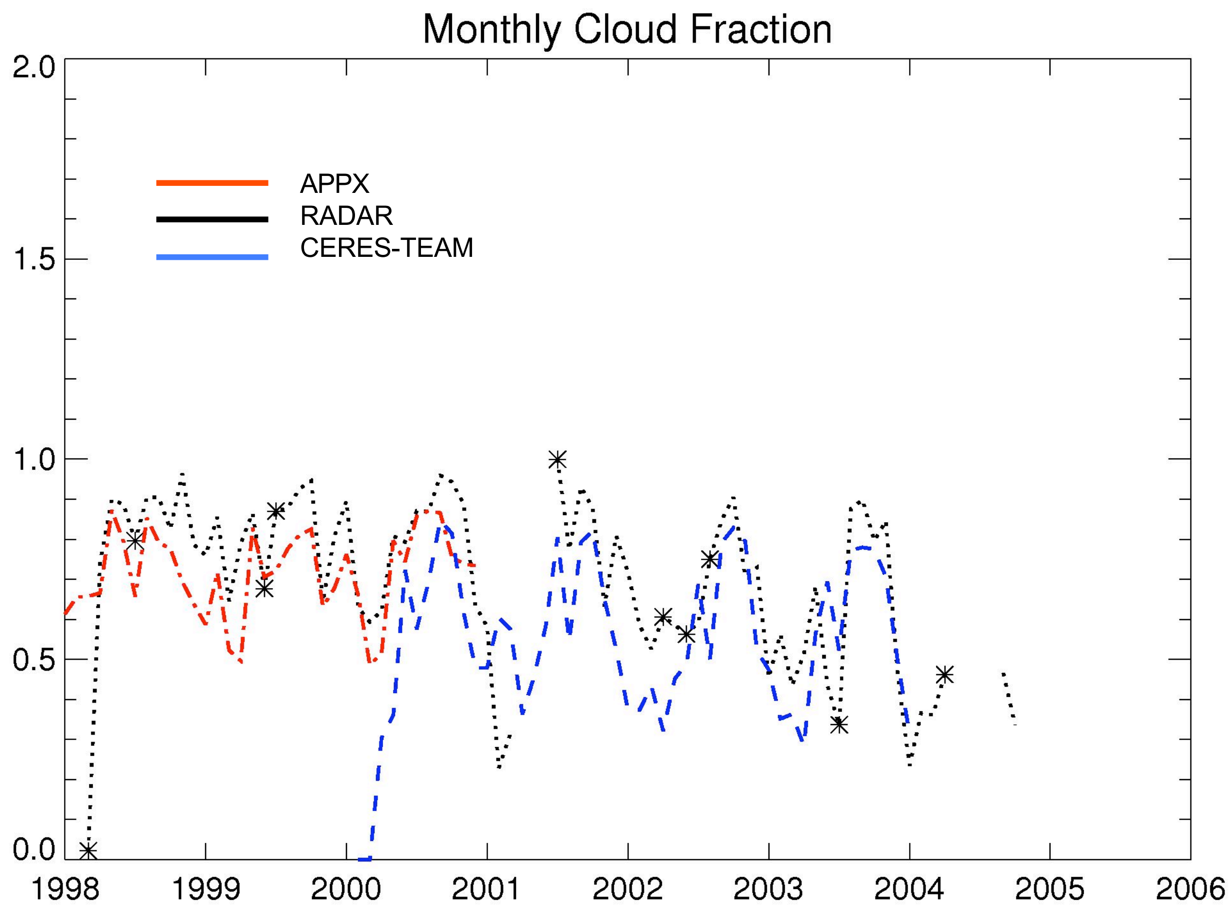

Monthly Mean Cloud Fraction
CLOUD FRACTION
1.0
0.8
0.6
0.4
0.2
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
RADAR
APPX
CERES
TOVS
Year = 2000



Monthly Mean Tau
RADAR
APPX
CERES
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

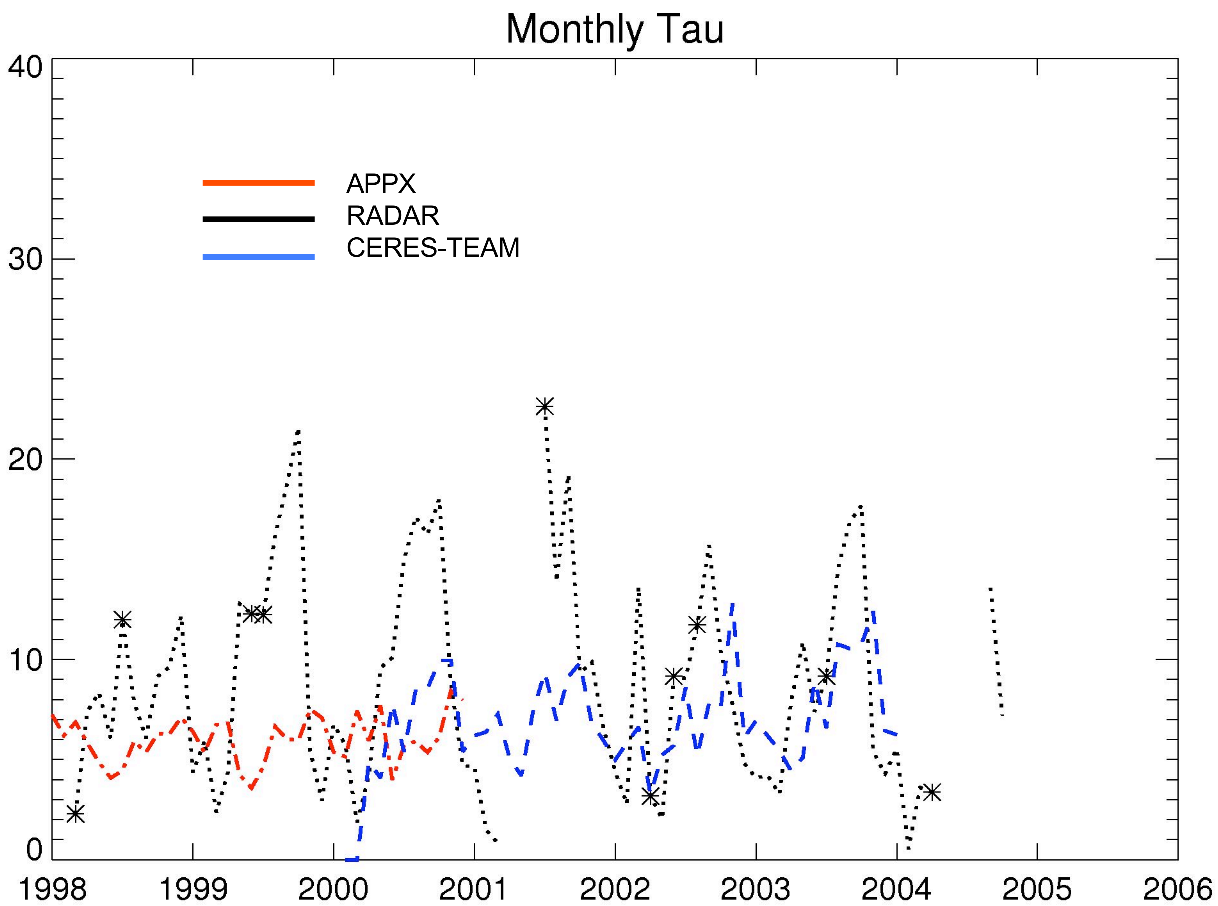
Monthly Average Cloud Fraction

(* indicate months will less than 15 days of radar data)

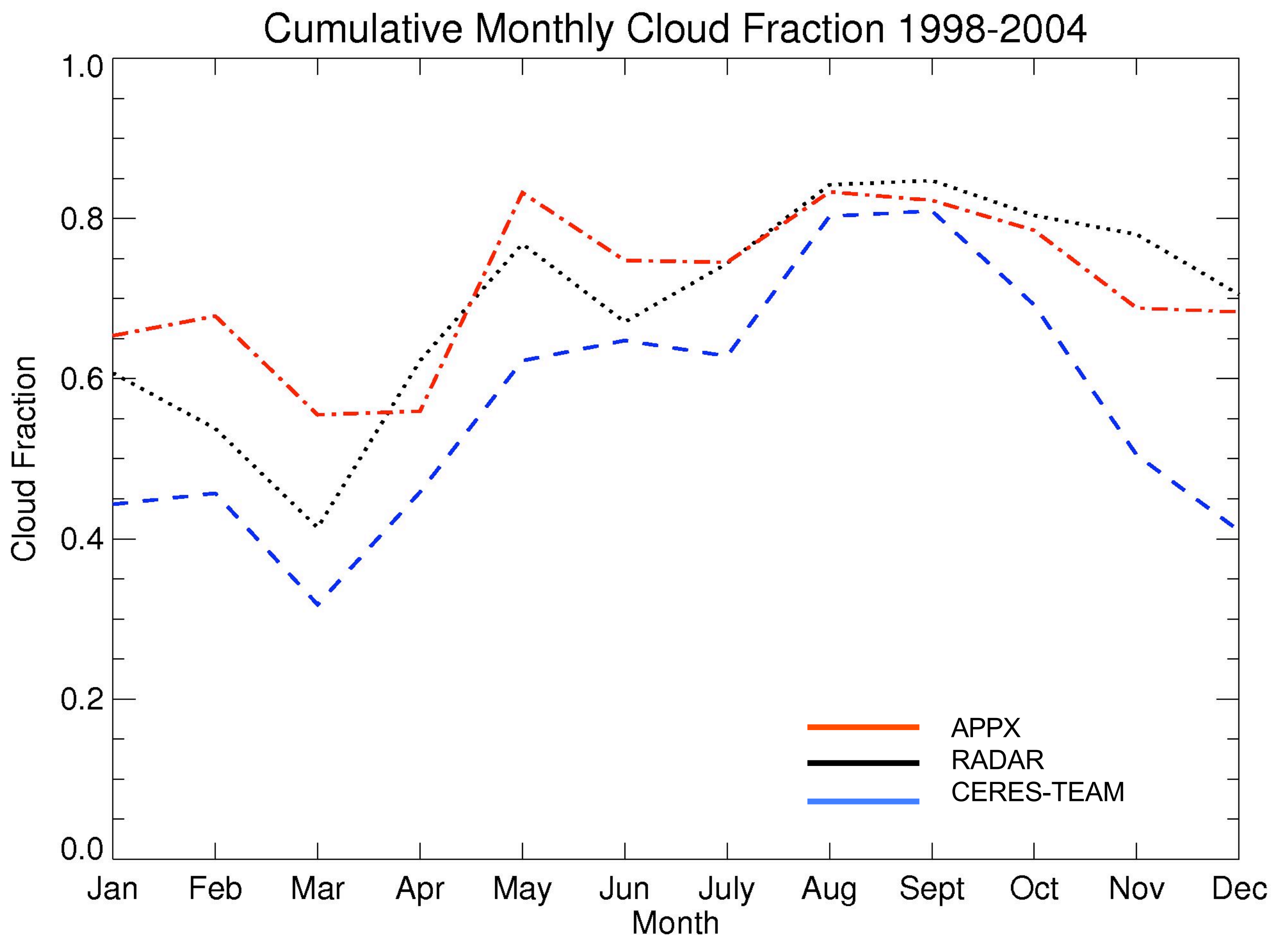


Monthly Averages of Cloud Optical Depth

(* indicate months will less than 15 days radar of data)

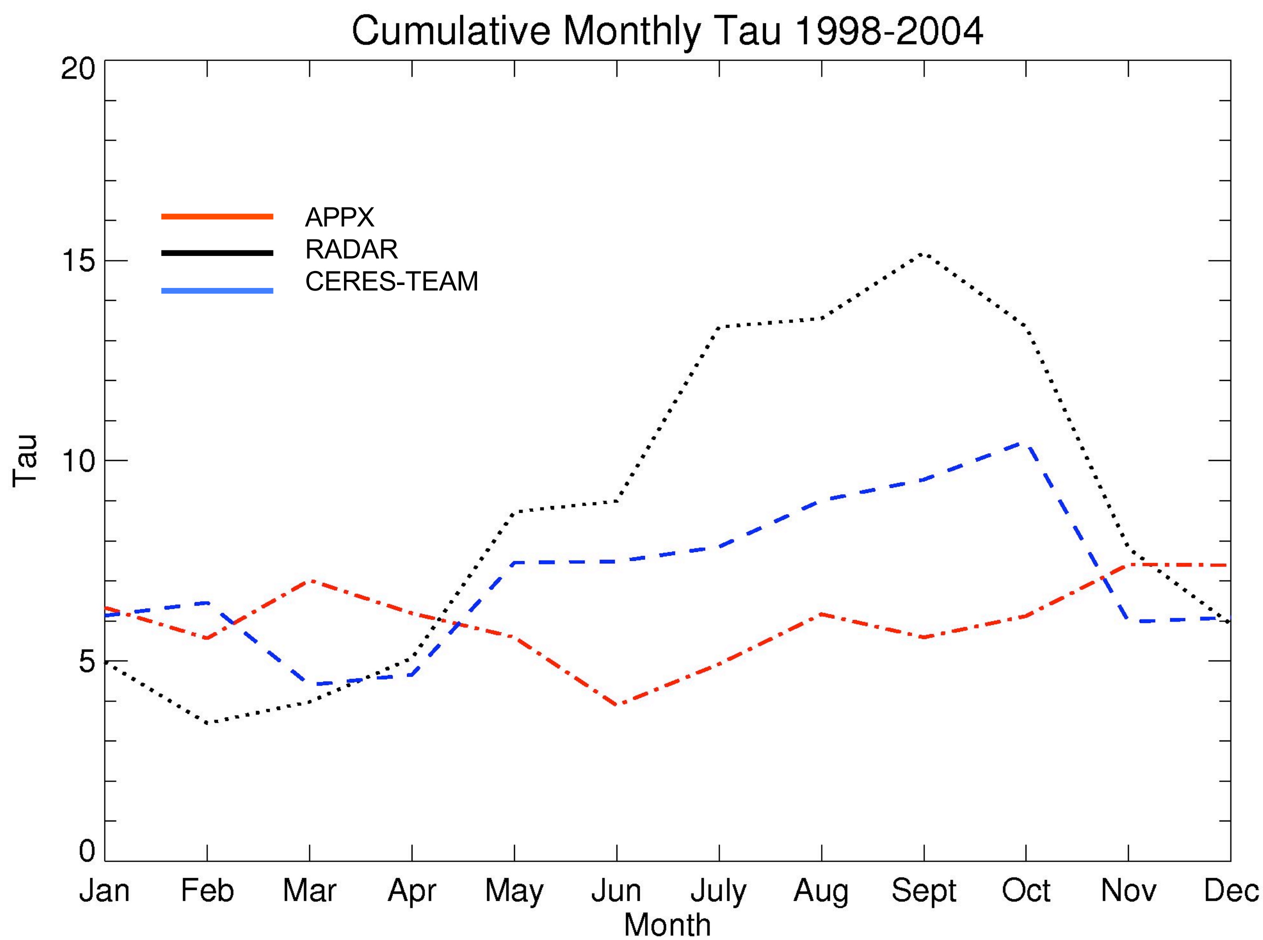


Monthly Averages of Annual Cycle of Cloud Fraction



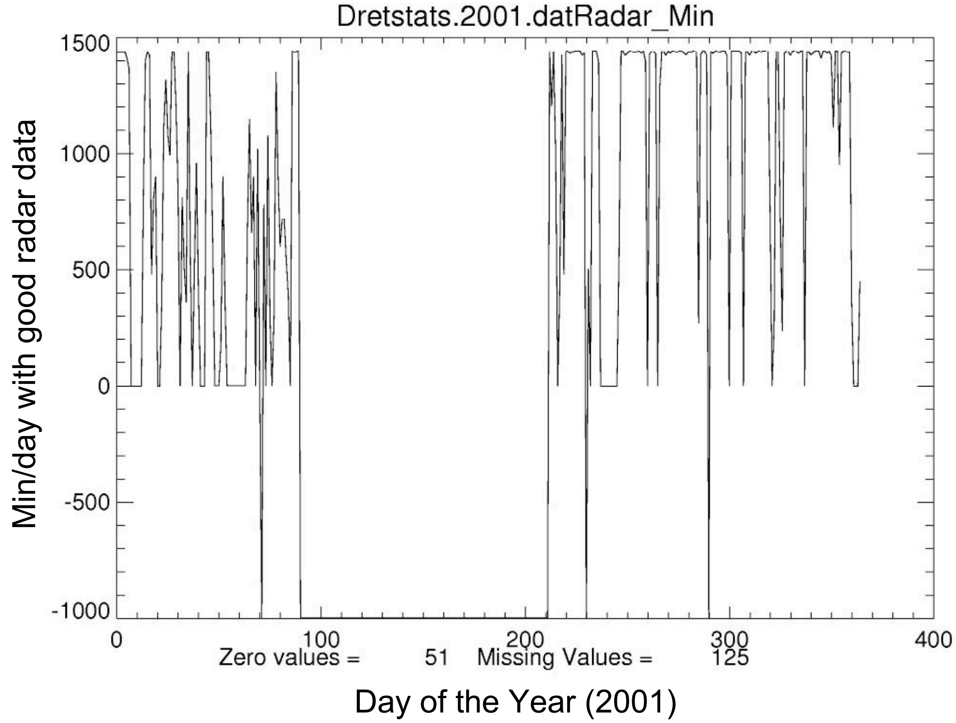
Note: APPX data calculated from 1998-2000
CERES TEAM data calculated from 2000-2003

Monthly Averages of Annual Cycle of Cloud Optical Depth

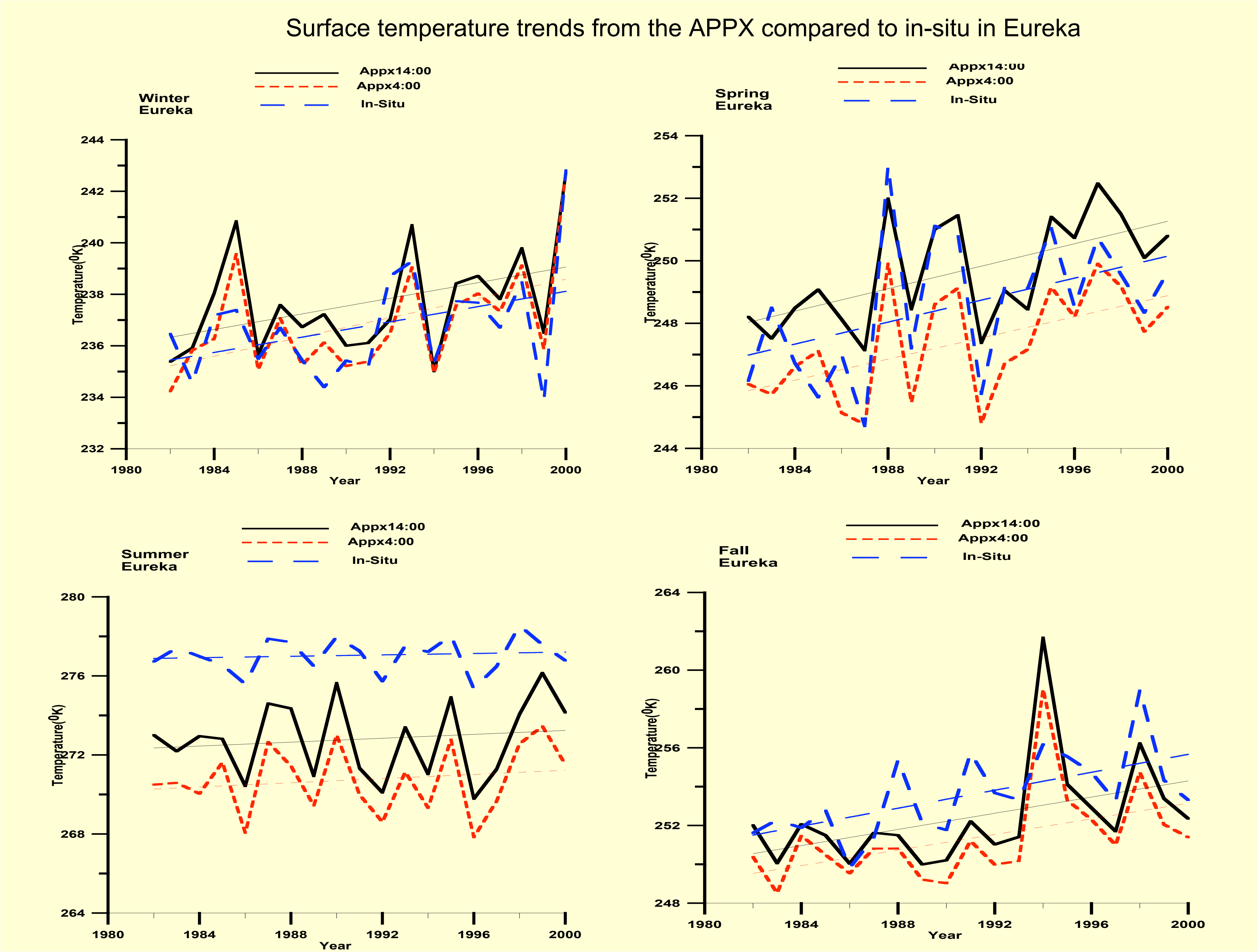


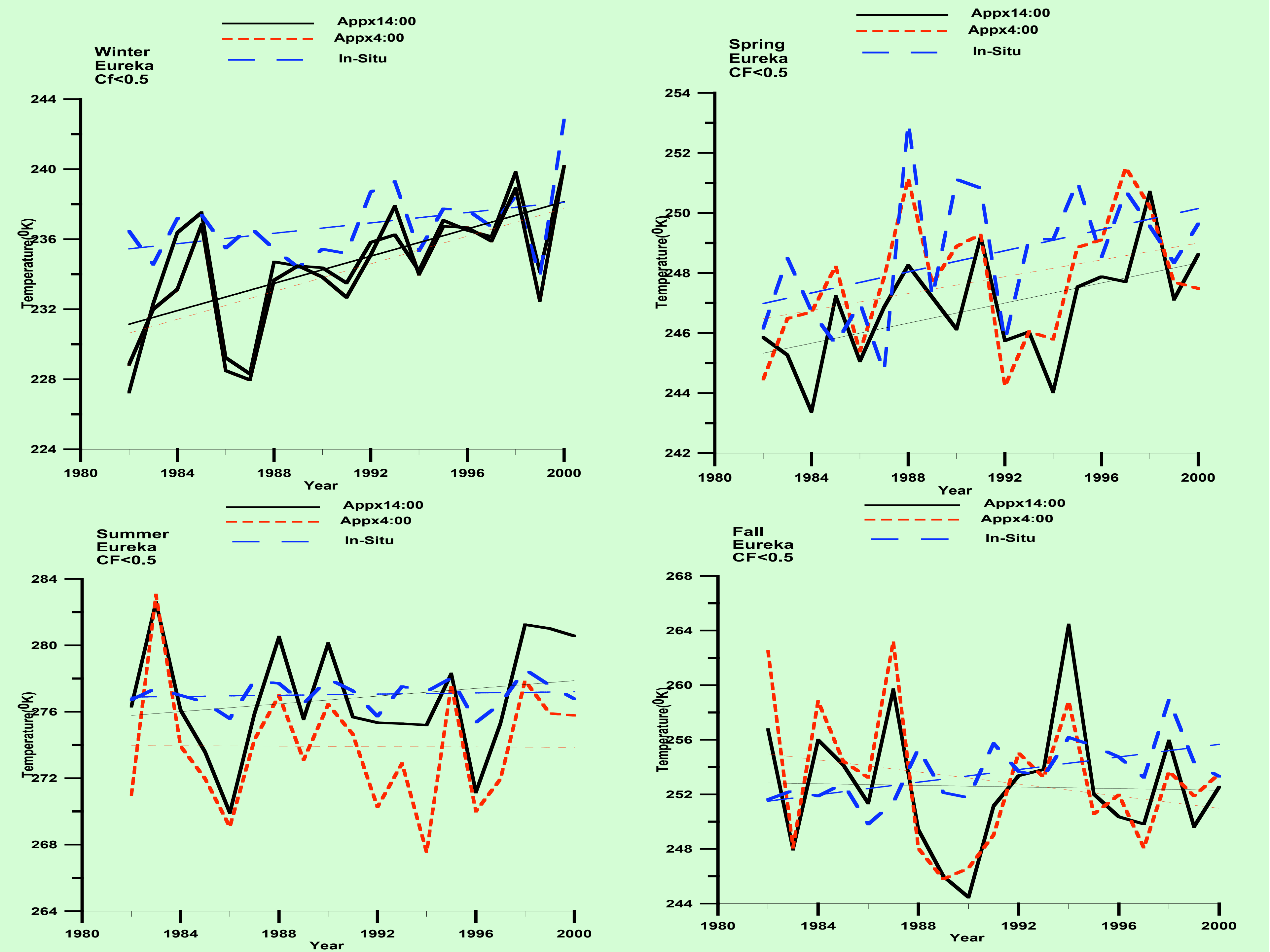
Note: APPX data calculated from 1998-2000
CERES TEAM data calculated from 2000-2003

The bad news is that the radar data set at NSA is not very continuous.



Year	Days with Missing Files	Days with 0 min of good Data
1998		
1999	46	38
2000	2	22
2001	51	125
2002	2	107
2003	1	47
2004	NOT YET PROCESSED	


Surface temperature trends from the APPX compared to in-situ in Eureka
Winter
Eureka
Appx14:00
Appx4:00
In-Situ
Temperature(0K)
Year
Spring
Eureka
Appx14:00
Appx4:00
In-Situ
Temperature(0K)
Year
Summer
Eureka
Appx14:00
Appx4:00
In-Situ
Temperature(0K)
Year
Fall
Eureka
Appx14:00
Appx4:00
In-Situ
Temperature(0K)
Year


Appx14:00
Appx4:00
In-Situ
Winter
Eureka
Cf<0.5
Temperature(0K)
Year
Spring
Eureka
CF<0.5
Summer
Eureka
CF<0.5
Fall
Eureka
CF<0.5

Preliminary Comparisons and Work in Progress

The CERES-Team, APP-X and TOVS all appear to agree well with each other and with the surface radar data monthly mean values of cloud fractions even when annual cycles are calculated from different years. Monthly variability also is well captured.

The APP-X appears to have problems with detecting annual trends in optical depth, in particular the increase in summer time resulting from increased frequency of liquid layers in clouds. The CERES-TEAM retrievals are doing better, but may still be underestimating summer-time cloud optical depths. (Radar-based optical depths have not been well validated for larger optical depths > ~8.0)

Clouds may be creating a significant bias in detection of summer surface temperatures in the Arctic

We are presently adding the PATMOS-X, standard cloud MODIS product and ISCCP to the comparisons

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